

## **SYSTEMS AND METHODS FOR ENHANCED OVER-THE-AIR PROGRAMMING**

### **BACKGROUND**

#### **1. Field of the Inventions**

[001] The field of the invention relates generally to over-the-air programming of mobile subscriber units and more particularly to termination of over-the-air programming calls.

#### **2. Background Information**

[002] Wireless carriers often provide services beyond voice communications in order to provide additional services, conveniences, and features to the mobile phone subscriber. Over-the-air (OTA) programming of a mobile subscriber units, including mobile phones, has become a common method of supplementing services with additional functionality and convenience. The term “mobile subscriber unit” is intended to refer to mobile phones, wireless enabled Personal Digital Assistants (PDA), laptops or other handheld devices, or any other devices that can be used for wireless communications.

[003] An example of OTA programming in a CDMA network is over-the-air parameter administration (OTAPA), which is governed by the IS-683A standard. An OTAPA call is often initiated by the service provider and can be invoked when parameters to an existing mobile subscriber unit need to be update.

[004] Another example of OTA programming in a CDMA network is over-the-air service provisioning (OTASP), which is also governed by the IS-683A standard. OTASP is used to provide a method to activate a new subscriber for wireless service. In a conventional service provisioning, a customer would purchase a mobile subscriber unit and go to an

activation center. A service provider would establish a user profile, Number Assignment Module (NAM), International Mobile Subscriber Identity (IMSI), Roaming Lists and optionally, service and manufacturer specific parameters. In addition, an authentication key and generation procedure can be established. The same service can be provisioned using OTASP, however, in order to reduced costs to the service provider and make the process more convenient for the customer.

[005] In a typical OTASP provisioning scenario, a customer contacts a service provider either through the use of a different mobile subscriber unit or using an IS-683A OTASP dialing scheme. The customer can supply sufficient information to verify credit worthiness. The mobile subscriber unit then initiates an over-the-air programming call and a service can be provisioned over-the-air.

[006] Though OTAPA and OTASP are given as two significant methods of OTA programming, there are other possibilities for OTA programming, such as synchronization of tones, programming of new ring tones, etc. Furthermore, OTA programming is not restricted to CDMA networks. It should be kept in mind, however, that OTA programming can be network initiated, e.g., OTAPA, or user initiated, e.g., OTASP.

[007] Figure 1 is a flow chart illustrating an exemplary OTA programming process. First in, step 100 the OTA programming session is initiation. Again, initiation can be controlled by the service provider as is the case for an OTAPA call. After initiation in step 100, a mutual authentication of both the service provider and the mobile subscriber unit can occur as shown in step 102. In step 104, the programming of a parameter, profile, or other data can then take place. If multiple parameters, profiles, or data are to be programmed, then the process can return to step 104. Once programming is complete, the OTA programming

session is concluded in step 108. In step 110, the service provider then terminates the call by releasing the allocated communication channel.

[008] Under certain conditions, however, it has been observed that the OTA call may not properly terminate. This can occur, for example, either because the mobile subscriber unit is not informed that the OTA call has concluded, or because the service provider does not properly initiate the release of the communication channel. During this period, the service provider perceives the mobile subscriber unit to be in use, which can prevent the subscriber from receiving calls. For example, because parameter administration or other OTA functions, can occur without the subscriber being aware, i.e., when the OTA session is network initiated, there can be no indication on the mobile subscriber unit informing the subscriber that an OTA session is occurring. Alternatively, the indication can be transient and the subscriber may not see it. As a result, if the OTA-session does not terminate properly and the communication channel is still in use, then the subscriber may unknowingly miss incoming calls. Additionally, the subscriber will be unable to initiate a call until the mobile subscriber unit releases the communication channel used for the OTA call. Battery power is also being drained needlessly while the subscriber unit remains on the communication channel. Since battery power is a precious resource in mobile communication devices, this can be a significant drawback.

## **SUMMARY OF THE INVENTION**

[009] Embodiments of this invention supplement the termination process by having the mobile subscriber unit terminate an OTA call upon completion of an OTA programming session. In one embodiment, the termination is initiated by the mobile subscriber unit after every session. In another embodiment, the termination is initiated after the network fails to

terminate the call. In another embodiment, the termination is only initiated in circumstances where it is known that the service provider has failed to terminate the call.

[010] These and other features, aspects, and embodiments of the invention are described below in the section entitled “Detailed Description of the Preferred Embodiments.”

### **BRIEF DESCRIPTION OF THE DRAWINGS**

[011] Features, aspects, and embodiments of the inventions are described in conjunction with the attached drawings, in which:

[012] Figure 1 is a flowchart illustrating an exemplary OTA programming session;

[013] Figure 2 is a diagram illustrating an example situation in which a mobile subscriber unit can experience a problem releasing an OTA call;

[014] Figure 3 is a flow chart illustrating an OTA programming session in accordance with one embodiment of the invention;

[015] Figure 4 is a diagram illustrating an exemplary mobile subscriber unit configured with improved OTA programming handling.

### **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

[016] Current standards for many OTA programming applications dictate that the call termination process that releases the allocated channel assigned to a mobile subscriber unit during the OTA programming session be initiated on the network side. However, as described in the background section, under certain conditions the call termination process is not initiated, or not perceived by the mobile subscriber unit to be initiated by the service provider upon completion of the OTA session.

[017] One scenario in which the failure to terminate has been observed is illustrated in figure 2. In the example of figure 2, a subscriber moves from a digital wireless network 204 to an analog network 202, while engaged in an OTA call. For example, a subscriber can travel along a freeway in their vehicle 206 with their mobile subscriber unit (not shown). While in digital network 204, the mobile subscriber unit can be engaged in an OTA call through base station 210 over digital communication channel 212. As vehicle 206 transitions from point A to point B, however, it can pass from digital network 204 to analog network 202. When this occurs, the OTA call can be transitioned from digital network 204 to analog network 202. The transition process is normally referred to as a hand-off. After a hand-off, the mobile subscriber unit can be engaged in the same OTA call through base station 208 over analog communication channel 214.

[018] The OTA call can, for example, follow the process flow depicted in figure 1. Therefore, when the OTA session ends (step 108), analog network 202 should end the OTA call (step 110) and release the mobile subscriber unit. As explained above, however, it is not uncommon for the mobile subscriber unit to stay connected, i.e., fail to be released. Again, as explained above, failure to release the mobile subscriber unit can cause the mobile subscriber unit to use excessive power and prevent it from sending or receiving calls, because the mobile subscriber unit is still on analog communication channel 214.

[019] For example, when the mobile subscriber unit is engaged in a call, the network with which it is interfaced can be configured to notify the subscriber of another incoming call using a “flash with info. message.” This assumes that the subscriber has call waiting and that the network allows calls to connect while in an OTA call, e.g., an OTAPA call. If either of these are not the case, then the other call is just missed. A “flash with info. message” can

comprise an audible tone played in the ear piece of the mobile subscriber unit and an “incoming call indication” displayed on the display of the mobile subscriber unit. Thus, the subscriber is likely to notice that another call is being received. But if the subscriber is unaware that the mobile subscriber unit is in an OTA call, then the subscriber likely will not hear the audible tone, because the subscriber will not be listening to the ear piece, or notice the display. As a result, the subscriber can easily miss the other incoming call.

[020] In addition, when the mobile subscriber unit is engaged, e.g., in an OTAPA call, analog communication channel 214 can still be engaged when the subscriber unit then transitions back into a digital network 218 if call termination failed as described above. Transitioning back to digital network 218 can only occur, however, when analog communication channel 214 is dropped, allowing the mobile subscriber unit to find digital service in digital network 218. But if the mobile subscriber unit is still engaged in the OTA call due to failed call termination, then it cannot drop analog communication channel 214 to find the digital service. Thus, the mobile subscriber unit cannot transition back to digital network 218.

[021] It should be noted that an OTA call, such as an OTAPA call, can be paged, i.e., use control channels to communicate with the mobile subscriber unit, or “piggy-backed” on a regular call. In either case, a failed call termination can occur. But the situation can be worse for a paged call, because the subscriber will often be unaware that the OTA call is taking place.

[022] Figure 3 is a flow chart illustrating an example method of an OTA programming session in accordance with the systems and methods described herein. In the example process of figure 3, an OTA call is initiated, in step 302, for a specific mobile

subscriber unit. In step 304, OTA messages are exchanged. Once all OTA messages are exchanged, and the OTA session has ended, the mobile subscriber unit can be configured to detect the end of the OTA session in step 306. The mobile subscriber unit can be configured to then release the OTA call in step 308, once the end of the OTA session is detected in step 306.

[023]           The detection of the end of the OTA programming session (step 306) can be implemented through a variety of mechanism. For example, a time-out period can be stored in the mobile subscriber unit. If an OTA message is not received within the time-out period, then the mobile subscriber unit can be configured to release the OTA call. Alternatively, an OTA programming protocol message that specifies the programming session has concluded can be implemented. In such an embodiment, the mobile subscriber unit can be configured to release the OTA call, upon receipt of message.

[024]           In another embodiment, the mobile subscriber unit can release the call only if a situation is detected that is known to cause a call release failure after an OTA session. For instance, as explained in relation to figure 2, call release failure can occur when a mobile subscriber unit transitions from a digital network 204 to an analog network 202 during an OTA session. Thus, the mobile subscriber unit can be configured to detect when such a transition occurs during an OTA session. The mobile subscriber unit can then be configured to terminate the OTA session when such a transition is detected. In such embodiment, the methods for detecting the end of the OTA session described above can, for example, still be used to detect the end of the OTA session.

[025]           Figure 4 is a diagram illustrating an exemplary mobile subscriber unit configured with improved OTA programming handling in accordance with the systems and

methods described herein. Mobile subscriber unit 400 can comprise an antenna 402, a transceiver 404, a microprocessor 406, memory 408, and a user interface 410. Antenna 402 can be coupled to the transceiver 404, which can be coupled to the microprocessor 410. The microprocessor can be coupled to memory 408 and to a user interface 410. User interface 410 can include, for example, a display configured to display information to a subscriber.

[026] Transceiver 404 can comprise receiver 416, which is configured to receive wireless communication signals from antenna 402. Receiver 416 is also preferably configured to filter and amplify the received signals. The received signals are also demodulated by receiver 416. Receiver 416 demodulates the received signal in order to generate a baseband information signal. Typically, a demodulator comprises two stages: the first stage steps the frequency of a received signal down from a Radio Frequency (RF) to an Intermediate Frequency (IF). The IF frequency signal is then stepped down, in the second stage, to baseband. The baseband information signal is then sent to microprocessor 406. Transceiver 404 also includes transmitter 418, which is configured to modulate wireless communication signals generated by microprocessor 406 and send them to antenna 402 to be transmitted.

[027] Microprocessor 406 preferably includes various circuits for controlling the operation of mobile subscriber unit 400 in general, and in particular for controlling communication using transceiver 404. Thus, microprocessor 406 can include various analog-to-digital (A/D) and digital-to-analog (D/A) converters, processors, Digital Signal Processors (DSPs), Vocoder, and peripheral control circuits as required by a particular mobile subscriber unit 400. Alternatively, some or all of these circuits can be included in mobile



subscriber unit 400 as stand alone components or as components incorporated into the various components of transceiver 404 or processor 406.

[028] Mobile subscriber unit 400 also preferably includes memory 408. Memory 408 can be used to store the software instructions used by transceiver 404. Thus, memory 408 can comprise a single memory device or a plurality of devices as required by the particular implementation of mobile subscriber unit 400.

[029] Additionally, mobile subscriber unit 400 can comprise an end session detector 412 configured to detect the end of an OTA session. End session detector 412 can be implemented as a separate hardware unit as depicted in the diagram in figure 4 or it can be resident as software in memory 408. In other embodiments, end session detector 412 can comprise a combination of hardware and software. End session detector 412 detects the end of an OTA session using one of methods described above. Thus, for example, end session detector 412 can be configured to detect the end session message received via antenna 402 and processed by microprocessor 406. Alternatively, end session detector 412 can comprise a timer (not shown) configured to count for a time out period. If an OTA message is not received by the time the timer times out, then end session detector 412 can be configured to detect the end of the OTA session.

[030] Mobile subscriber unit 400 can also comprise a call terminator 420. Call terminator 420 can be configured to end the OTA call when end session detector 412 detects the end of the OTA session. Call terminator 420 can be implemented in hardware, software, or a combination thereof. In general, call terminator 420 comprises the same hardware and/or software normally included in a mobile subscriber unit for ending a call.

[031] In another embodiment, mobile subscriber unit 400 can comprise a circumstance evaluator 414. Circumstance evaluator 414 can be implemented as a separate hardware unit as shown in figure 4 or it can be implemented as software resident in memory 408. In other embodiments, circumstance evaluator 414 can comprise a combination of hardware and software. Circumstance evaluator 414 determines when conditions in which an OTA call may not be properly released using one of the methods described above.

[032] While certain embodiments of the inventions have been described above, it will be understood that the embodiments described are by way of example only. Accordingly, the inventions should not be limited based on the described embodiments. Rather, the scope of the inventions described herein should only be limited in light of the claims that follow when taken in conjunction with the above description and accompanying drawings.